

WHAT IS CLAIMED IS:

1. An apparatus comprising:
 - an integrated circuit (IC) die having a front surface on which an integrated circuit is formed and a rear surface that is opposite to the front surface;
 - 5 a member to define at least one microchannel at the rear surface of the IC die, the microchannel to allow a coolant to flow therethrough; and
 - at least one thin film thermoelectric cooling (TFTEC) device in the at least one microchannel.
2. The apparatus of claim 1, wherein the at least one TFTEC device is formed on the 10 rear surface of the IC die.
3. The apparatus of claim 2, wherein the member has a front side which faces the rear surface of the IC die, said front side of the member having at least one groove therein to define the at least one microchannel.
4. The apparatus of claim 1, wherein the member is an integrated heat spreader.
- 15 5. The apparatus of claim 4, wherein the member is formed of copper.
6. The apparatus of claim 1, wherein the member is formed of silicon.
7. The apparatus of claim 1, wherein the member is formed of copper.

8. The apparatus of claim 1, wherein the coolant includes water.
9. The apparatus of claim 8, wherein the coolant is de-ionized water
10. The apparatus of claim 1, wherein the TFTEC device includes one of silicon germanium superlattice and beryllium telluride.

5 11. The apparatus of claim 1, wherein the member is bonded to the rear surface of the IC die.

12. The apparatus of claim 11, further comprising a heat spreader; the member interposed between the heat spreader and the rear surface of the IC die;

10 the at least one microchannel including:

- a first tier of microchannels defined by the rear surface of the IC die and by grooves in the member; and
- a second tier of microchannels defined by a rear surface of the member and grooves in the heat spreader, the second tier of microchannels being above the first tier of microchannels.

15 13. The apparatus of claim 12, wherein the at least one TFTEC device is formed on the rear surface of the IC die.

14. The apparatus of claim 11, further comprising a heat spreader;

the member interposed between the heat spreader and the rear surface of the IC die;

the at least one microchannel including:

5 a first tier of microchannels defined by the rear surface of the IC die and
by grooves in the member; and

a second tier of microchannels defined by a front surface of the heat spreader and grooves in the member, the second tier of microchannels being above the first tier of microchannels.

15. The apparatus of claim 1, wherein the integrated circuit formed on the front surface
10 of the IC die is a microprocessor.

16. The apparatus of claim 1, wherein the at least one TFTEC device includes at least
one pair of stacked TFTEC devices.

17. A method comprising:

15 flowing a coolant through a microchannel at a rear surface of an integrated circuit
(IC) die; and

cooling the IC die with a thin film thermoelectric cooling (TFTEC) device formed
on the rear surface of the IC die and located in the microchannel.

18. The method of claim 17, wherein the flowing includes flowing the coolant through
two tiers of microchannels adjacent the rear surface of the IC die.

20 19. The method of claim 17, wherein the coolant includes water.

20. The method of claim 19, wherein the coolant is de-ionized water.
21. The method of claim 17, wherein the TFTEC device includes one of silicon germanium superlattice and beryllium telluride.
22. The method of claim 17, wherein the microchannel is defined by a groove formed in a front side of a member, the front side of the member facing the rear surface of the IC die.
23. A system comprising:
 - an integrated circuit (IC) die having a front surface on which a microprocessor is formed and a rear surface that is opposite to the front surface;
 - 10 a member to define at least one microchannel at the rear surface of the IC die, the microchannel to allow a coolant to flow therethrough;
 - at least one thin film thermoelectric cooling (TFTEC) device in the at least one microchannel; and
 - a chipset in communication with the microprocessor.
- 15 24. The system of claim 23, wherein the at least one TFTEC device is formed on the rear surface of the IC die.
25. The system of claim 24, wherein the member has a front side which faces the rear surface of the IC die, said front side of the member having at least one groove therein to define the at least one microchannel.

26. The system of claim 23, wherein the TFTEC device includes one of silicon germanium superlattice and beryllium telluride.

27. The system of claim 23, further comprising:

a coolant circulation system to supply the coolant to the at least one microchannel.

5 28. The system of claim 27, further comprising:

a drive circuit to supply electrical power to the at least one TFTEC device.